

WHAT IS CLAIMED IS:

1. A gas concentration measuring apparatus comprising:  
a gas sensor configured to measure a concentration of a specified  
5 gas component contained in a gas and to output a sensor current  
corresponding to the measured concentration of the specified gas  
component; and  
a measurement substrate where an electric circuit is formed, said  
electric circuit being electrically connected to the gas sensor and including  
10 a signal processing circuit configured to measure the sensor current  
outputted from the gas sensor,  
wherein said electric circuit comprises:  
a connection terminal electrically connected to the gas sensor and  
configured to input the sensor current from the gas sensor, said  
15 connection terminal having input impedance of 500 k $\Omega$  or over;  
a conductive pattern portion having conductivity and formed in  
the measurement substrate; and  
an electric component mounted on the conductive pattern portion,  
said conductive pattern portion including:  
20 a signal input pattern constituting the signal processing circuit  
and electrically connected to the connection terminal, said signal input  
pattern having direct current impedance with respect to the connection  
terminal, said direct current impedance being 10 percent or less of the  
input impedance of the connection terminal;  
25 a different potential pattern having a potential difference of 2 V or  
over from a potential of the signal input pattern; and

a guard pattern having a substantially constant potential and a potential difference of less than 0.5 V from the potential of the signal input pattern, said guard pattern being arranged on at least a portion of the measurement substrate, said at least portion of the measurement 5 substrate being located between the signal input pattern and the different potential pattern.

2. The gas concentration measuring apparatus according to  
claim 1, wherein said guard pattern has a potential difference of less than  
10 0.2 V from the potential of the signal input pattern.

3. The gas concentration measuring apparatus according to  
claim 1, wherein said input impedance of the connection terminal has  $1\text{ M}\Omega$  or more.

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4. The gas concentration measurement apparatus according to  
claim 1, wherein said signal input pattern has direct current impedance of  
2  $\text{k}\Omega$  or less from the input impedance of the connection terminal.

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5. The gas concentration measurement apparatus according to  
claim 1, wherein said different potential pattern has a potential difference  
from the potential of the signal input pattern, said potential difference  
being 4 V or more.

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6. The gas concentration measurement apparatus according to  
claim 1, wherein said signal input pattern includes a plurality of signal

input patterns, said different potential pattern includes a plurality of different potential patterns, and said measurement substrate comprises a surface conductive layer where the signal input patterns, the different potential patterns, and the guard pattern are formed; and an insulating 5 layer on which the surface conductive layer is mounted, and  
wherein said at least portion of the measurement substrate is located at a distance between at least one of the signal input patterns and at least one of the different potential patterns, said at least one of the signal input patterns and at least one of the different potential patterns 10 being adjacent to each other.

7. The gas concentration measurement apparatus according to claim 1, wherein said signal input pattern includes a plurality of signal input patterns, said different potential pattern includes a plurality of different potential patterns, said guard patterns includes a plurality of guard patterns, said measurement substrate comprises a plurality of conductive layers; and a plurality of insulating layers so that the conductive layers and the insulating layers are alternately laminated with each other, one of said conductive layers corresponding to a surface 15 portion of the measurement substrate, another one of said conductive layers being adjacent to the one of the conductive layers through one of the insulating layers interposed therebetween, said signal input patterns are formed in the one of the conductive layers, said different potential patterns are formed in the one of the conductive layers, said guard 20 patterns are formed in both of the one of the conductive layers and another one thereof, respectively, said at least portion of the measurement 25

substrate is located at a distance between at least one of the signal input patterns and at least one of the different potential patterns in the one of the conductive layers, said at least one of the signal input patterns and at least one of the different potential patterns is adjacent to each other  
5 therein, and

wherein at least one of said guard patterns formed in another one of said conductive layers is arranged in an area of another one of the conductive layers, said area being opposite to at least one of the signal input patterns formed in the one of the conductive layers.

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8. The gas concentration measurement apparatus according to claim 1, wherein said conductive pattern portion further comprises a signal measurement pattern constituting a path having output impedance of 500  $\Omega$  or less with respect to ground of the measurement substrate  
15 and the signal processing circuit, and said guard pattern is electrically connected to the signal measurement pattern.

9. The gas concentration measurement apparatus according to claim 8, wherein said signal processing circuit comprises an operational amplifier having an output terminal and electrically connected to the signal input pattern, said operational amplifier being configured to input the potential of the signal input pattern and to output a voltage that substantially equals to the inputted potential, said output terminal of the operational amplifier being electrically connected to a portion of the signal measurement pattern, and said guard pattern is electrically connected to the portion of the signal measurement pattern.  
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10. The gas concentration measurement apparatus according to  
claim 8, wherein said signal processing circuit comprises an operational  
amplifier having non-reverse input terminal, a reverse input terminal and  
5 an output terminal, said reverse input terminal being electrically  
connected to the connection terminal, said operational amplifier being  
configured to control that the potential applied on the non-reverse input  
terminal substantially coincides with the potential of the connection  
terminal, said non-reverse input terminal of the operational amplifier  
10 being electrically connected to a portion of the signal measurement  
pattern, and said guard pattern is electrically connected to the portion of  
the signal measurement pattern.

11. The gas concentration measurement apparatus according to  
15 claim 1, wherein said guard pattern is arranged to surround the signal  
input pattern.

12. The gas concentration measurement apparatus according to  
claim 1, wherein said different potential pattern comprises an exposed  
20 portion around which no insulating coating is formed, and a coating  
portion around which an insulating coating is formed, and said guard  
pattern comprises an exposed adjacent portion arranged adjacent to the  
exposed coating portion, and a coating adjacent portion arranged adjacent  
25 to the coating portion, said exposed adjacent portion being formed with no  
insulating film therearound, said coating adjacent portion being formed  
with an insulating film therearound.

13. The gas concentration measurement apparatus according to  
claim 1, wherein said gas sensor comprises a pair of sensor cells each of  
which outputs the sensor current, said measurement substrate comprises  
5 a pair of the signal processing circuits, one of said signal processing  
circuit is electrically connected to one of said sensor cells, other of said  
signal processing circuits is electrically connected to other of said sensor  
cells, one of said signal processing circuits is configured to correct the  
sensor current outputted from one of said sensor cells according to the  
10 sensor current measured and outputted from the other of the signal  
processing circuit.

14. The gas concentration measurement apparatus according to  
claim 1, wherein said specified gas component is one of NO<sub>x</sub>, CO and HC.

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15. A gas concentration measuring apparatus comprising:  
a gas sensor configured to measure a concentration of a specified  
gas component contained in a gas and to output a sensor current  
corresponding to the measured concentration of the specified gas  
20 component; and

a measurement substrate where an electric circuit is formed, said  
electric circuit being electrically connected to the gas sensor and including  
a signal processing circuit configured to measure the sensor current  
outputted from the gas sensor,

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wherein said electric circuit comprises:

a connection terminal electrically connected to the gas sensor and

configured to input the sensor current from the gas sensor, said connection terminal having input impedance of 500 k $\Omega$  or over;

a conductive pattern portion having conductivity and formed in the measurement substrate; and

5 an electric component mounted on the conductive pattern portion, said conductive pattern portion including:

a signal input pattern constituting the signal processing circuit and electrically connected to the connection terminal, said signal input pattern having direct current impedance with respect to the connection 10 terminal, said direct current impedance being 10 percent or less of the input impedance of the connection terminal;

a different potential pattern having a potential difference of 2 V or over from a potential of the signal input pattern; and

15 a guard pattern having a substantially constant potential within a range from 80 percent or more to 120 percent or less of the potential of the signal input pattern, said guard pattern being arranged on at least a portion of the measurement substrate, said at least portion of the measurement substrate being located between the signal input pattern and the different potential pattern.

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16. The gas concentration measuring apparatus according to claim 15, wherein said guard pattern has a potential difference of less than 0.2 V from the potential of the signal input pattern.

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17. The gas concentration measuring apparatus according to claim 15, wherein said input impedance of the connection terminal has 1

M  $\Omega$  or more.

18. The gas concentration measurement apparatus according to  
claim 15, wherein said signal input pattern has direct current impedance  
5 of 2  $k\Omega$  or less from the input impedance of the connection terminal.

19. The gas concentration measurement apparatus according to  
claim 15, wherein said different potential pattern has a potential  
difference from the potential of the signal input pattern, said potential  
10 difference being 4 V or more.

20. The gas concentration measurement apparatus according to  
claim 15, wherein said signal input pattern includes a plurality of signal  
input patterns, said different potential pattern includes a plurality of  
15 different potential patterns, and said measurement substrate comprises a  
surface conductive layer where the signal input patterns, the different  
potential patterns, and the guard pattern are formed; and an insulating  
layer on which the surface conductive layer is mounted, and

wherein said at least portion of the measurement substrate is  
20 located at a distance between at least one of the signal input patterns and  
at least one of the different potential patterns, said at least one of the  
signal input patterns and at least one of the different potential patterns  
being adjacent to each other.

25 21. The gas concentration measurement apparatus according to  
claim 15, wherein said signal input pattern includes a plurality of signal

input patterns, said different potential pattern includes a plurality of different potential patterns, said guard pattern includes a plurality of guard patterns, said measurement substrate comprises a plurality of conductive layers; and a plurality of insulating layers so that the 5 conductive layers and the insulating layers are alternately laminated with each other, one of said conductive layers corresponding to a surface portion of the measurement substrate, another one of said conductive layers being adjacent to the one of the conductive layers through one of the insulating layers interposed therebetween, said signal input patterns 10 are formed in the one of the conductive layers, said different potential patterns are formed in the one of the conductive layers, said guard patterns are formed in both of the one of the conductive layers and another one thereof, respectively, said at least portion of the measurement substrate is located at a distance between at least one of the signal input 15 patterns and at least one of the different potential patterns in the one of the conductive layers, said at least one of the signal input patterns and at least one of the different potential patterns is adjacent to each other therein, and

wherein at least one of said guard patterns formed in another one 20 of said conductive layers is arranged in an area of another one of the conductive layers, said area being opposite to at least one of the signal input patterns formed in the one of the conductive layers. .

22. The gas concentration measurement apparatus according to 25 claim 15, wherein said conductive pattern portion further comprises a signal measurement pattern constituting a path having output impedance

of 500  $\Omega$  or less with respect to ground of the measurement substrate and the signal processing circuit, and said guard pattern is electrically connected to the signal measurement pattern.

5        23. The gas concentration measurement apparatus according to claim 22, wherein said signal processing circuit comprises an operational amplifier having an output terminal and electrically connected to the signal input pattern, said operational amplifier being configured to input the potential of the signal input pattern and to output a voltage that substantially equals to the inputted potential, said output terminal of the operational amplifier being electrically connected to a portion of the signal measurement pattern, and said guard pattern is electrically connected to the portion of the signal measurement pattern.

15        24. The gas concentration measurement apparatus according to claim 22, wherein said signal processing circuit comprises an operational amplifier having non-reverse input terminal, a reverse input terminal and an output terminal, said reverse input terminal being electrically connected to the connection terminal, said operational amplifier being configured to control that the potential applied on the non-reverse input terminal substantially coincides with the potential of the connection terminal, said non-reverse input terminal of the operational amplifier being electrically connected to a portion of the signal measurement pattern, and said guard pattern is electrically connected to the portion of the signal measurement pattern.

25. The gas concentration measurement apparatus according to  
claim 15, wherein said guard pattern is arranged to surround the signal  
input pattern.

5           26. The gas concentration measurement apparatus according to  
claim 15, wherein said different potential pattern comprises an exposed  
portion around which no insulating coating is formed, and a coating  
portion around which an insulating coating is formed, and said guard  
pattern comprises an exposed adjacent portion arranged adjacent to the  
10 exposed coating portion, and a coating adjacent portion arranged adjacent  
to the coating portion, said exposed adjacent portion being formed with no  
insulating film therearound, said coating adjacent portion being formed  
with an insulating film therearound.

15           27. The gas concentration measurement apparatus according to  
claim 15, wherein said gas sensor comprises a pair of sensor cells each of  
which outputs the sensor current, said measurement substrate comprises  
a pair of the signal processing circuits, one of said signal processing  
circuit is electrically connected to one of said sensor cells, other of said  
20 signal processing circuits is electrically connected to other of said sensor  
cells, one of said signal processing circuits is configured to correct the  
sensor current outputted from one of said sensor cells according to the  
sensor current measured and outputted from the other of the signal  
processing circuit.

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28. The gas concentration measurement apparatus according to

claim 15, wherein said specified gas component is one of nitrogen oxides, carbon monoxide, and hydrocarbon.